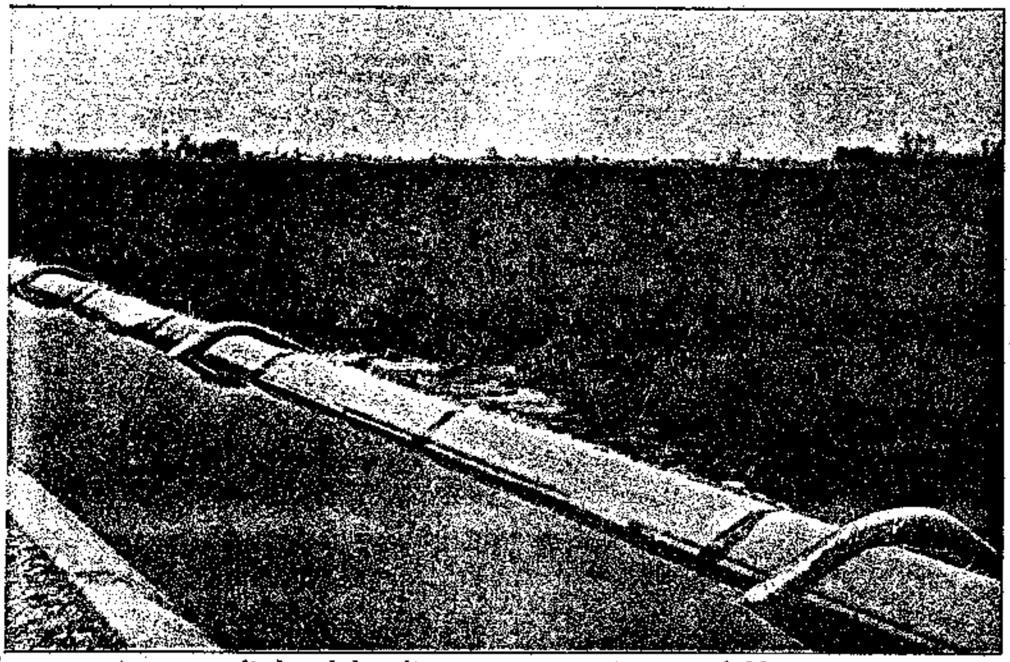
Closed Cycle Industrial Wastes Control



A concrete ditch and the adjacent wastewater irrigation field growing grass.

by Jay H. Smith and James H. Oates

Irrigation of the wastewater at the J. R. Simplot Company's potato processing plant in Caldwell, Idaho, makes it possible to keep the wastewater out of the river and avoid potential pollution problems. In addition to this, the nutrients in the effluent are used to grow grass and corn, which represents a significant portion of the rations for the Simplot cattle raising operation located nearby.

Also, the potato wastes solids from the processing plant have been successfully fed to the cattle as a substantial portion of the total ration.

In 1972, the state of Idaho Department of Environment began enforcing the wastewater discharge regulations imposed by the federal government. Potato processors in Idaho had been discharging wastewater with various levels of treatment to receiving streams. To meet the more stringent discharge guidelines or to eliminate discharge to streams, several developed wastewater irrigation projects and applied the potato processing effluent to agricultural land.

In 1972, the company's potato processing plant had a wastewater discharge of approximately 8 mgd. They started with an irrigation project covering approximately 250 acres of land and, in the course of the next three years, increased the acreage to the present size of about 800 acres.

Since 1972, wastewater has not been discharged into the adjacent Boise River. All of the wastewater, with a flow of 4.5 mgd, was applied to land, where grass and corn were grown, utilizing part of the otherwise wasted nutrients and preventing the pollution that was originally occurring. During the first three years of this irrigation project, the wastewater quality and clean-up was evaluated as it passed through the soil.

Wastewater Sources

The processing plant wastewater originates from several sources. The potatoes are brought into the plant and washed in preparation for peeling and processing. The washing water is settled in a mud pond and the effluent is irrigated separately from these wastes. The peeling process is the so-called "dry-lye" process and the semi-solid peel wastes are kept separated from the waste stream and used for livestock feed. Other plant waste streams (from blanching, washing, transporting processed product and other sources) are then discharged from the plant to a primary clarifier system. The primary clarifier overflow (2,600 to 3,100 gpm) flows to a retention pond and then to the field for irrigation.

Another source of wastewater (75 to 125 gpm) is the livestock feeding operation, where a number of livestock are fed on a slotted corral. Manure is worked into the slots and water carries it into a manure reclamation unit where the solids are separated from the liquid waste. These liquid wastes then go into the same retaining pond as the potato processing effluent.

The clarifier underflow is combined with the peeling waste in a pit silo and later used for livestock feed. The wastewater flow pattern is shown in **Fig. 1**.

Wastewater Irrigation

The fields used for irrigation were saline when the potato processing plant was constructed. This condition was caused by a high water table in the area. The large volume of water pumped from the aquifer for the plant lowered the water table and allowed reclamation of the saline solid through leaching the salts from the surface.

In preparing the land for wastewater irrigation, the fields were leveled to a slope of approximately 0 to 0.1 percent. Concrete ditches were installed for distributing the wastewater to the fields. The field edges and lower ends were diked to prevent runoff and seeded to various grass mixtures, which are harvested and fed to livestock.

Runoff is collected at the low end of the fields in ditches, routed to three central collection points, pumped back to three 40-acre fields, and sprinkled on grass.

During this wastewater irrigation development at the Simplot Company, the quantity of water used in the plant has been monitored and decreased appreciably. At present, the amount of water used and thus the wastewater discharged, has decreased from the original 8 mgd to approximately 4 to 4.5 mgd. In some instances this has increased the organic material and nutrient concentrations. The daily 4.5 mgd of effluent spread over 800 acres provides, on the average, an application depth of 4 in. per month, or a total of 48 in. per year. There has been uneven distribution, with some fields receiving considerably more and others less water than the average. Steps are now being taken to obtain a more equal distribution to provide uniform fertilization, better nutrient utilization and more uniform crop yields.

Water Quality

The wastewater composition is shown in Table 1, which represents average conditions obtained over a period of several months. The chemical oxygen demand, total Kjeldahl nitrogen, nitrate nitrogen, phosphorus, potassium,. magnesium calcium, sodium and SAR (sodium absorption ratio) are given. The pounds of fertilizer nutrients in an acre-inch of wastewater are also reported along with their current market value.

For comparison of the nutrient cleanup as the water passes through the soil, the same nine parameters as reported in the wastewater were measured in the groundwater sampled at about the 9 ft depth. The removal of COD and plant nutrients is essentially 100 percent. The residual 30 mg of COD in the groundwater is about the level present in such samples in that area, with or without organic matter addition to the fields.

Loading rates for organic matter and nutrients are as follows: Organic matter additions to the field were about 20,000 lb COD/acre each year. Approximately 770 lb nitrogen, 140 lb phosphorus and 1,525 lb potassium/acre were applied each year. Most of the nitrogen can be utilized by the growing crop. Phosphorus and potassium are in excess of the needs of the growing crop, but should not pose pollution hazards. In this system excess nitrogen is denitrified because of the relatively shallow water table. Groundwater quality is good, and in most cases meets the minimum standards for culinary water as established by the U.S. Environmental Protection Agency. Nitrate-nitrogen averaged 0.3 mg/l which is lower than the 10 mg/l maximum in the water quality standards.

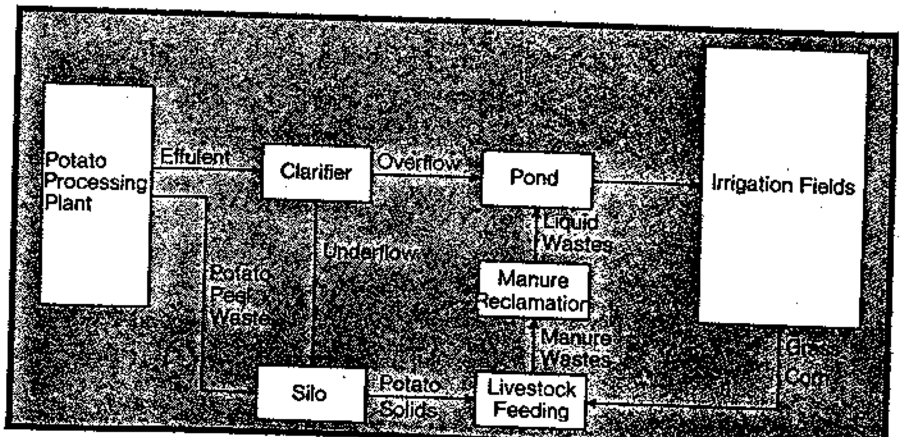


Figure 1. A schematic diagram of the waste management system.

Table 1
Average Composition of Potato Processing Wastewater and Groundwater

	Wastewater	Lb/Acre In	Value/Acre In 1/	Groundwater
COD	1,880 mg/l	—	—	30 mg/l
TKN	71 mg/l	16.1	$4.19	0.8 mg/l
NO_3—N	0.7 mg/l	.2	$0.05	0.3 mg/l
P	13.2 mg/l	3.0	$2.28	0.15 mg/l
K	3.6 meq/l	31.8	$6.04	0.15 meq/l
Mg	0.4 meq/l	—	—	1.2 meq/l
Ca	1.2 meq/l	—	—	2.9 meq/l
Na	4.9 meq/l	—	—	5.2 meq/l
SAR	3.7	—	—	3.6

Value calculated on the basis of N — $0.26/lb, P — $0.76/lb, and K — $0.18/lb. (Market quotations for treble superphosphate, muriate of potash and aqua ammonia—March 22, 1982 in Idaho.)

Table 2
Analytical Characteristics of the Forage

	TKN (Percent)	NO_3—N mg/l	P (Percent)	K (Percent)
1973	2.70	866	0.38	3.46
1974	2.21	1,840	0.32	3.02
1975	2.86	200	0.36	3.46

Cropping

In the first years of wastewater irrigation, the fields were all planted to perennial grasses. The grass was harvested either by swathing, field chopping and ensiling or by grazing with livestock. Harvesting with machinery and removing the harvested grass to be fed elsewhere is preferred. Grazing with livestock compacts the soil and decreases water infiltration more rapidly than does machinery. In the fourth and fifth cropping years, soil compaction became a problem in some fields, and most of them were renovated in rotation by plowing and seeding to corn. The corn was then also ensiled and used for livestock feed. The fields were then again seeded with grass.

The total percentages of Kjeldahl nitrogen, nitrate nitrogen, phosphorus and potassium in the forage are shown in Table 2. Nitrogen levels are relatively high, as are nitrate concentrations in the grass harvested in 1974. In managing these fields it is desirable to periodically analyze forage samples for nitrate concentration. Nitrates-nitrogen in excess of about 2,000 mg/l may be hazardous to livestock. If high nitrate concentrations are encountered, the forage nitrate can usually be decreased by ensiling and allowing denitrification to occur during the fermentation process, or by mixing the forage with lower nitrate materials before feeding. The phosphorus concentrations in the feed are adequate to relatively high, as is the case with potassium.

The average yields of green chopped grass in 1980 and 1981 were 20 and 18 tons/acre, respectively (dry weight), with a range from 5 to 45 tons/acre for 30 fields. This wide variation in yield indicates that with improved water management, the yield can be increased. The value of the grass and corn grown on the wastewater irrigated fields partially compensates for the treatment costs in the potato processing wastewater treatment system. Since the dry grass has a value of $60 per ton, at a yield of 25 tons/acre, the value of the crop from each acre would be $1,200.

Summary

Wastewater irrigation has proved to be a highly efficient effluent utilization system for the potato processing plants. With proper management these systems can be expected to operate for a long time with minimum environmental impacts and with a high degree of treatment. A difficult pollution problem has been solved and some of the nutrients and water that were wasted are now being used for growing forages, thus saving nutrients and energy. ■

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